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Review on Clean Development Mechanism (CDM) implementation in Malaysia

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ABSTRACT

Clean Development Mechanism (CDM) appears to be a catalyst to reduce the cost of renewable energy projects in Malaysia. Carbon credit gained from developed countries enhances financial states of the nation and potentially pushes forward renewable energy industries. Most of the registered CDM projects are related to renewable energy, which recorded 69% out of total projects. This paper adopted to-date data from GreenTech Malaysia in order to present the CDM projects in energy sector. Institutional framework has been discussed to demonstrate the registration in CDM cycle. Although the extent of CDM's successfulness is controversial, the number of registered CDM projects in energy sector is in rising trend and helps in large amount of emission reductions in Malaysia particularly through biomass and biogas projects. CDM should encourage more new renewable technology including wind energy and tidal energy in Malaysia.

Contents

1. Introduction

The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as "A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods". Apparently, the UNFCCC believes that climate change is boosted by human activities such as agriculture, industrialisation, transportation, deforestation and open burning. Many countries join the UNFCCC in order to reduce average global temperature together. Rises in global temperature lead to climate change.

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The effects of greenhouse gases (GHGs) are more outstanding than expected [1]. As a result, the Kyoto Protocol has been adopted as an international agreement under the UNFCCC since 1997 and entered into force on 2005 to reduce the GHGs emission. The Kyoto Protocol has three mechanisms—Clean Development Mechanism (CDM), Joint Implementation (JI) and Emission Trading (ET). Among these three, the CDM is the most acclaimed mechanism in developing countries as it brings profits to them. Furthermore, it involves technology transfer which enhances the environment through sophisticated technology. The CDM involves both the developed and developing countries. It permits the developed country to achieve their commitments by materialising emission reductions in developing country [2]. It is essential in promoting sustainable development via technology transfer and investment. Besides, GHGs which results in climate change can be reduced through this mechanism [3].

The renewable energy is replacing the other energy sources and may become one of the main contributors of global energy system in the future. Developing countries are the potential renewable energy resources supplier. The Kyoto mechanisms play an important role in realising technology transfer from developed country to developing country [4]. Besides, technology transfer brings economic benefits to the projects that are already economically sound [5].

As a developing country, Malaysia joined the CDM voluntarily as one of the non-Annex I countries. After becoming a member in the UNFCCC on 9 June 1993 and following by the ratification on 13 July 1994, Malaysia became a member in the Protocol officially on 4 September 2002 [6]. Many projects in Malaysia have been successfully registered as CDM projects. This had motivated other corporate sectors in the country such as power manufacturing, waste management, forestry, oil and gas manufacturing, agriculture and transportation sectors to proactively participate in CDM projects applications.

Thereinafter, Malaysian Government has been highly supportive and instrumental in CDM participation. A comprehensive administrative committee was set up upon the requirement of CDM. Besides, the Budget 2008 extends 10 years pioneer status to companies involved in energy conservation, with 3 years tax exemption for income derived from the carbon trading in the country. These are encouraging news to the project developers as the process of application can be done smoothly with the assistance of the group of committee.

This paper is written in order to provide an overview of the Malaysia's energy projects which are registered in CDM including the entire process of CDM projects approval by the CDM institutional administration. In addition, successfulness of the CDM projects is still a controversial issue which largely debated among the scientists and environmentalists. The study discusses the CDM implementation to push forward the development of renewable energy industries in Malaysia.

2. Demand of renewable energy in Malaysia

Malaysia is a tropical country located in the Southeast Asia consisting of two major lands which are Peninsular Malaysia (West Malaysia) and Malaysian Borneo (East Malaysia). These two lands are separated by the South China Sea which is a part of the Pacific Ocean. The Strait of Malacca situated next to the East Peninsular Malaysia is acting as a borderline for the territories of Malaysia and Indonesia. The country consists of a total land area and water area of 328,657 km^2 and 1,190 km^2 respectively [7,8]. Abundant easily accessible natural resources such as sunlight and water make Malaysia a suitable country to use renewable energies including hydropower, solar power, tidal power and wave power.

Undeniably, increase in renewable energy utilisation is a global trend. ASEAN countries are still in low renewable energy usage, however, in rising trends [9]. In order to inherit this global trend, Malaysia enacted several relevant policies which gave impetus to renewable energy popularity within the energy market. Since the implementation of Four-Fuel Diversification Strategy in 1981, hydro was the first renewable energy introduced to the country's energy market. The policy was revised in 1999 to become the Five-Fuel Diversification Strategy. Renewable energy was the fifth fuel in the energy supply mix with target of 5% electricity contribution by 2005.

An estimation done by the International Energy Agency (IEA) demonstrates that, the global energy consumption is foreseen to increase 53% by 2030. The expected main utilisation is coming from developing countries, with a 70% of growth in demand. These growth trends intensify the world challenge regarding the limitations in energy supply and it followed by resources crisis [10]. A report by the Ministry of Energy, Green Technology and Water (KeTTHA) in Malaysia shows that, the maximum demand for electricity in Peninsular Malaysia is 15,473 MW in May 2011, which is a 2.7% increment compared to previous year. This projection rate will lead the peak demand to reach 21 GW in 2020 and 25 GW in 2030 respectively. The electricity consumption growth increased 6.5% in 2011 compared to 2010, which was driven by commercial and domestic sectors with 9.2% and 7.4% rise, respectively. These growth trends illustrate the potential of higher energy demand as the country is striving to grow towards a high-income economy. By 2020, around 10.8 GW of new generation capacity will be required by the country as 7.7 GW of existing capacity will be terminated. By that time, the total installed capacity will rise up 16% if compared to the total installed capacity in 2011 [11].

The electric power consumption in Malaysia is growing substantially from 1970 until now. Over the last four decades, the usage of electricity in the country has been largely increased due to the rapid economical growth attributed to industrialisation and high density of development [12]. Primary energy supplies in Malaysia for year 2011 and 2001 is shown in Figs. 1 and 2. Crude oil and natural gas are the major energy sources. Approximately 47% of total energy supply comes from crude oil in 2001. However, it decreased substantially to 31% out of total energy supply in 10 years. Over the period, natural gas substituted crude oil to become the leading energy source which accounts 45% out of total energy supply in 2011 compared to 40% in 2001.

The energy supply of coal and coke had been raised from 6% to 19% out of total commercial energy supply over 10 years from 2001. This circumstance is like turning the clock back as many

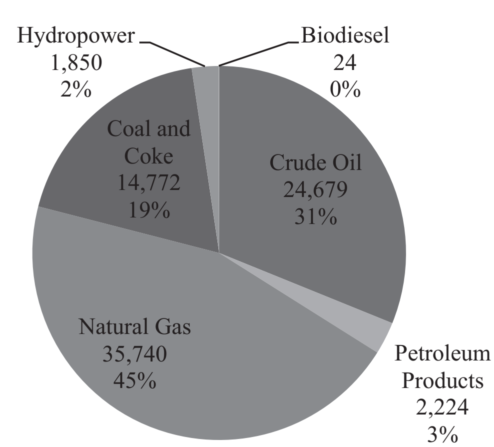


Fig. 1. Primary energy supply in Malaysia, 2011 (ktoe).
Source: Suruhanjaya Tenaga, 2011 [13].

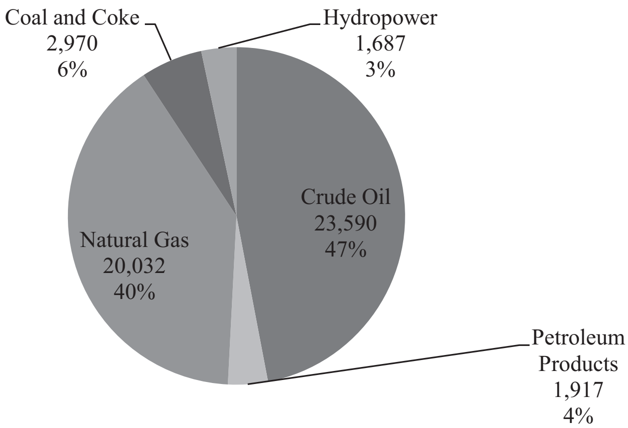


Fig. 2. Primary energy supply in Malaysia, 2001 (ktoe).
Source: Suruhanjaya Tenaga, 2011 [13].

proofs had shown that coal burning brings many negative effects to the environment. High concentration of airborne pollutants was observed in indoor air of coal-burning power plants [14]. The indoor airborne pollutants exhausted by combustion processes of coal are easily absorbed in the food and it may cause diseases if the food is consumed by the workers [15].

Amount of hydropower supply showed slight increment in 10 years from 1,687 ktoe in 2001 to 1,850 ktoe in 2011. However, the percentage of hydropower in total energy supply demonstrated slight decrease from 3% to 2%. This is due to vast increase in total energy supply, which is from 50,196 ktoe in 2001 to 79,289 ktoe in 2011. However, this technology is possible to create negative environmental impacts depending on the scale [16]. Therefore, the government is more supportive towards mini-hydro which minimises harmful impacts to the ecosystem. Biodiesel was first used in 2011 as one of the energy supply sources in Malaysia. Although merely 24 ktoe of energy supply had been reported, it is a good start for the energy system in Malaysia as renewable energy has been involved in the energy sector.

The major CO_2 emissions contributor is the energy industry, which accounts for 41% of entire emissions. It is followed by the transport industry and manufacturing industry, which recorded 23% and 20% of total emissions, respectively [17]. In the Copenhagen forum 2009, Malaysia has pledged to reduce 40% of carbon emissions by 2020 compared to 2005 levels, subject to assistance from developed countries [18]. This might be a turning point to the local market as environment consideration is not popular among the entrepreneurs, as some of them do not understand the mechanism of global warming and the effects of carbon emissions. So, the government's initiative may catalyse the participation of most of sectors to reduce carbon emissions in order to create a cleaner environment.

3. CDM projects in Malaysia

As shown in Appendix Table A1, CDM received a total of 4460 CDM projects in the pipelines by August 2012. Out of the total CDM projects, 69% is renewable energy projects. Most of the CDM projects are related to wind, hydro and biomass energy which recorded 2,523 projects (28%), 2,280 projects (26%) and 906 projects (10%), respectively.

Among the projects, there are 108 projects or 2.42% is in Malaysia as shown in Fig. 3. Malaysia belongs to the group of non-Annex I. Annex I includes the countries listed under Kyoto Protocol that commit to greenhouse gases (GHGs) emission reduction. They are formed by a group of developed countries such as Denmark, United Kingdom, Australia, United States etc. As a developing country, Malaysia has no quantitative commitments under Kyoto Protocol. Nevertheless, the country can voluntarily participate in globally reducing emissions of GHGs. Besides collaborating with industrialised country investors to develop new industries and technologies, the CDM pushes developing countries like Malaysia to create cleaner environment.

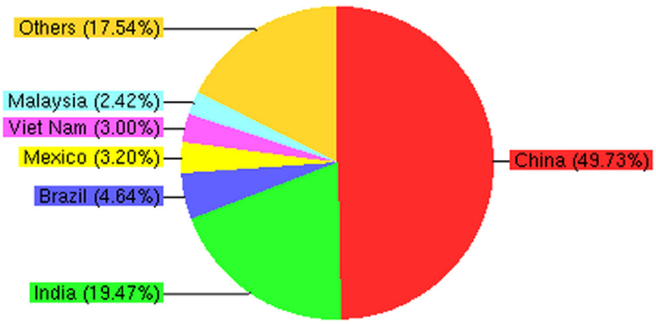


Fig. 3. Number of CDM projects by non-Annex I countries.
Source: UNFCCC, 2012 [19].

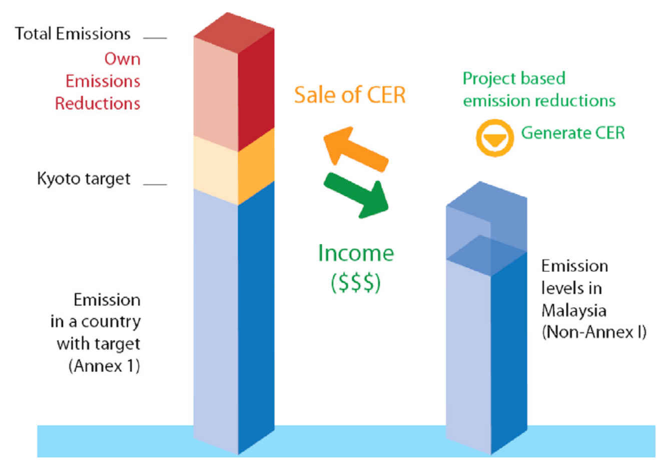


Fig. 4. Illustration on clean development mechanism.
Sources: Malaysia Energy Centre, 2008 [20].

Fig. 4 shows the operation of CDM schematically. As a commitment to the Kyoto Protocol, the Annex I Parties are committed to reduce quantified emissions to a certain level. The protocol limits the emissions from Annex I countries by an average of 5.2% of the 1990 level over a 5-year commitment period from 2008 to 2012. The emission reductions in developing countries are tradable under CDM. The Annex I countries thus purchase the 'emission reductions' from the non-Annex I countries such as Malaysia. Then, Malaysia can earn extra income for projects that reduce emissions by trading the certified emission reductions (CERs) to Annex I countries, besides contributing to sustainable development.

Since 4 September 2002, Malaysia had been ratified as a party in the Kyoto Protocol. Even though does not subjected to any commitments towards reducing GHGs emission, Malaysia had voluntarily participated in the CDM and involved in many GHGs emission reduction projects. The involved projects such as renewable energy projects, energy efficiency projects and waste management projects can gain extra revenues from the Annex I party. This is a win–win situation where the environment of Malaysia can be improved through reduction of GHG emissions, besides meeting the Annex I countries' targets in reducing the emissions to certain level as stated in the agreement of Kyoto Protocol. There are many types of projects which are eligible for CDM as shown in Table 1.

Table 1
Examples of projects Eligible for CDM.

Sector	Type of projects
Renewable energy	• Biomass power generation—on-grid and off-grid • Biogas power generation from POME, animal waste etc. • Solar: solar water heating; solar photovoltaic systems • Hydro: mini-hydro power
Energy efficiency	• Improving efficiency in electricity production • Improving combined heat and electricity production • Improved boilers; more efficient process heat and steam systems • Fuel switching • Energy efficiency through demand side management
Forestry	• Afforestation • Reforestation
Waste management	• Power and heat production from wastes • Gas recovery from landfills • Anaerobic waste water treatment
Transport	• Efficiency improvements for vehicles • Switch to fuel systems with lower emissions
Agriculture	• Composting of agriculture wastes • Methane abatement from animal waste • Methane reduction in rice cultivation

The Malaysian Energy Centre (PTM) predicts that the yearly potential in Malaysia reaches 18 million CERs in 2010. This is equal to approximately 100 million tonnes CO_2 equivalent from 2006 to 2012. Besides, PTM assumes the price range to be US$ 3–10 per tonne CO_2 equivalent. This is equivalent to a capital flow of US$ 0.3–1 billion to Malaysia by earning the carbon credits [21].

Both renewable energy and CDM are labelled as solution of environmental problems and climate change. Hence, they are in a good match contributing to sustainable development [2,22]. Both of them lead to sustainable development and contribute positive impacts to the nations. Therefore, it is not surprise that majority of the registered CDM projects are attributed to renewable energy industries.

3.1. Renewable energy based CDM projects

Renewable Energy (RE) Act 2011 is an act to provide establishment and implementation of a special tariff system to encourage renewable energies generation. SEDA is a statutory body formed under the Sustainable Energy Development Authority Act 2011 to administer and manage the implementation of Feed-in Tariff (FiT) mechanism which is mandated under RE Act 2011. The FiT allows electricity generated from indigenous RE (sources from within the country and are not imported from neighbouring countries) to be traded to power utilities such as Tenaga National Berhad (TNB) at a fixed premium price in a certain period. The distribution licensee will pay some amount of incentive to the clean energy power generator depending on the kilowatt hour (kWh) of electricity generated and exported to the national grid. To date, the FiT mechanism accepts electricity generated from four types of RE such as biogas, biomass, small hydro and solar photovoltaic, based on different FiT rates [23].

As shown in Fig. 5, most of the renewable energy in Malaysia is generated from biomass by end of October 2010. Three options of biomass are mass production of electricity by furnaces, fluidised boilers and pyrolysis, combined heat and power schemes for industry such as solution from bagasse (fibres from sugarcane) or paper and pulp as well as biodiesel. Biomass is easily available

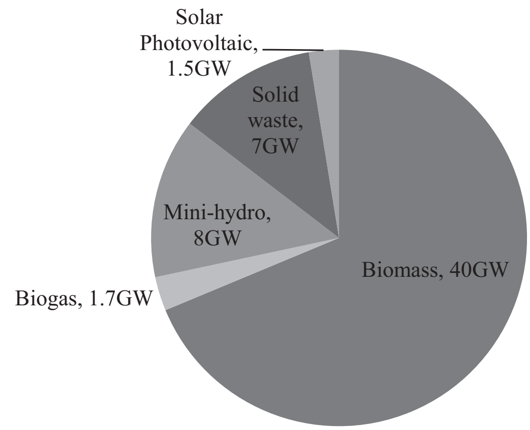


Fig. 5. Distribution of renewable energy connected to the grid.
Source: KeTTHA, 2012 [24].

since methane and other gases produced from dead organic matters can be found everywhere. However, burning of biomass contributes to global warming and particulate pollution. It is also difficult in collection and expensive [25]. Next, the mini-hydro is the second largest RE electricity supplier in Malaysia. It performs well in energy efficiency, cost effectiveness and electricity quality assurance. However, it cannot always achieve the required load demand due to the seasonal water flow variations [26,27]. Summer season is believed to bring less flow and followed by less power output. This might be a challenge particularly to tropical countries.

The increasing amount of solid waste has been a problem in the country. The solid waste generated in West Malaysia increased from 16,200 t metric per day in 2000 to 19,100 t metric in 2005. This trend is expected to bring 20,000 t metric per day of waste generation in 2020 [28,29]. Hence, waste to energy is a potential energy source that reduces negative environmental impacts as well. However, the capital cost is high and the production of electricity is expensive and complex [30]. Solar power is expected to be four-fold more than the world fossil fuel resources [31]. It emits zero greenhouse gas (GHG), hence, considered as a climate-friendly technology. Tropical country like Malaysia is suitable to adapt solar energy due to accessibility of large amount of sunshine and resource. Nevertheless, the cost of solar power is relatively high, which is three to four times of the cost of fossil fuel [32,33]. Therefore, CDM comes in the right position where it associates with energy policies in Malaysia encouraging more new renewable energy projects.

3.2. Potential of wind and tidal energy implementation

There are some other types of renewable energy which are yet to be accepted by the FiT system in Malaysia, however, recorded active registration in CDM. As presented in Appendix Table 1, wind energy recorded the highest registration CDM projects among all energy-related projects. A total of 2,523 (28%) wind energy projects had been registered by 2012 which are eligible for 71,729,000 CERs issuance. Wind energy generation in Malaysia depends on the location of wind resource. It has minor impacts to the environment and does not produce GHGs. Wind energy is having a great potential in windy areas such as tourist resort islands [34]. However, wind farms have to store the electricity so people can use it during those days when wind is insufficient [35]. More technical efforts inserted into this technology are anticipated leading to diversification of energy and solution of energy scarcity for future needs. Hence, involvement of technical transfer from developed countries through CDM is expected to solve this problem.

Tidal energy is another potential renewable energy which is worthwhile to be discussed [36–38]. It is a type of renewable energy that is new in Malaysia [39,40]. However, it is a potential energy source to the country as Malaysia possess high coast per area ratio, which is 14. The ratio is derived from the 4,675 km coastline and 328,550 km^2 land area [41]. The Straits of Malacca is a potential coastline to harvest tidal energy due to its constant minimum flow of 0.5 m/s and maximum flow of 4 m/s [42]. Tidal energy is more predictable than solar and wind energies. Since tides rely on the gravitational pull of the moon and sun, it generates reliable tidal energy [43]. The implementation of tidal energy needs more supports from the government due to its promising in energy source [44]. Only one tidal energy project is registered in CDM, which is expected to gain 1,104,000 Certified Emission Reductions (CERs) in 2012. In other word, tidal energy is foreseen to obtain 315 kCERs per year [45].

According to the annual reports of Asian Development Bank (ADB), 43% of bank's total energy sector investments are for renewable, while other 26% are for efficiency. Demand for energy and financing in developing Asian countries is expected to be great in the near future [46]. This means that renewable energy is more viable to be invested. Diversification of energy sources is a need to energy market in order to fulfil enormous energy requirement. Hence, new renewable energy technologies are expected contributing to more emission reductions and carbon credits.

4. The CDM institutional administration in Malaysia

The successfulness of CDM implementation in Malaysia is highly dependent on the extent of involvement of the government. In order to show rigorousness and determination in reducing GHGs emission through more declaration of CDM projects, Malaysia has a comprehensive administration framework in assisting the potential CDM projects within the nation. The establishment of an institutional framework is the CDM's requirements. The Malaysia's CDM institutional framework is shown in Fig. 6.

4.1. Ministry of natural resources and environment

The Ministry of Natural Resources and Environment (NRE) has been granted responsibility by the cabinet as the Designated National Authority (DNA), which is the highest level in the CDM institutional framework. A DNA is the body appointed by a party to authorise and approve participation in CDM projects. It is a must for a party to establish a DNA in order to join the CDM. To register a project with UNFCCC, the DNA of the country is required to come out with written approval. This letter of approval is an evidence of the project activity in contributing to sustainable development in the country. After that, a letter of approval will be submitted to CDM Executive Board (EB) to support the registration of the project. The DNA is empowered to issue relevant endorsement and host party approvals as well as handle the national regulatory aspects of the CDM. Hence, the DNA develops some national policies, strategies, criteria and guidelines for the implementation of CDM projects. In some extent, the DNA will consult National Committee on CDM (NCCDM) regarding the endorsement of CDM projects.

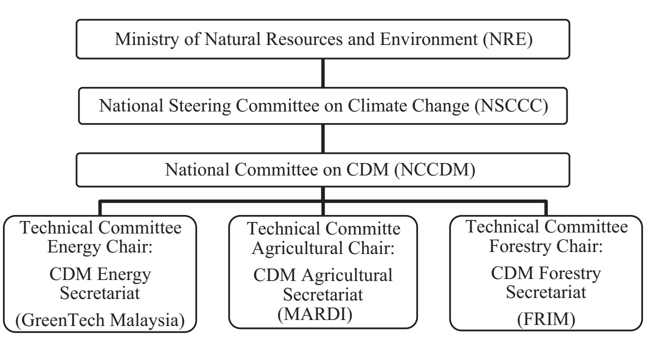


Fig. 6. The CDM institutional administration in Malaysia.
Source: *NRE, 2005* [6].

In fact, the DNA is playing a critical role in bridging the CDM Secretariat, the NCCDM members, Technical Committee on CDM (TCCDM) members and the developers. Any amends in the status of application will be informed by the DNA to the parties concerned. Also, the DNA will plan and call for NCCDM meeting at least three times every year by following the CDM Annual Schedule as attached. After the meetings, the DNA will prepare meeting minutes and send it to all members.

On the other hand, the continuance of the CDM projects registry is more difficult to be guaranteed because it depends on the efforts, determination and patience put by all parties. Thus, the DNA is the key body to monitor the CDM projects. They communicate with the project developers in maintaining the project activities based on an internationally recognised monitoring methodology as well as data on baseline and project boundary [47].

4.2. National Steering committee on climate change

The National Steering Committee on Climate Change (NSCCC) has been established since 1994 coincides with the ratification of Malaysia as a party in the UNFCCC. Then, the ratification of Malaysia in the Kyoto Protocol has impelled the establishment of National Committee on CDM (NCCDM) on 31 May 2002. This committee will directly be in charge of three technical committees, which are on energy, agricultural and forestry. The technical committees are chaired by the GreenTech Malaysia, Malaysian Agricultural Research and Development Institute (MARDI) and Forest Research Institute Malaysia (FRIM) respectively.

NSCCC is a committee established by the cabinet. It is chaired by the Secretary General of Ministry of NRE. The Conservative and Environmental Management Division of NRE is holding the position as Secretariat. The committee members are formed by representatives of government, private sector and Non-Government Organisations (NGOs). The NSCCC will be responsible to formulate national policy, strategy and action plan to reduce the impact of climate change. In addition, this committee is required to formulate and coordinate implementation plan related to climate change. They have to formulate and coordinate national action plan in meeting the commitment as agreed upon in the UNFCCC. Furthermore, they act as the national focal point for external financial and technical assistance for climate change programme and discuss Malaysia's point of views on issues regarding climate change in international platform [48].

4.3. National committee on clean development mechanism

Similar to NSCCC, the National Committee on CDM (NCCDM) is also formed by a group of committees. The chairperson of NCCDM is the Deputy Secretary General (Policy) of Ministry of NRE and the Secretariat of NCCDM is same as the Secretariat of NSCCC. The NCCDM will review and evaluate the proposals of CDM projects as requested by the Designated National Authority (DNA), as the CDM projects are against the policy related issues of the approved national CDM criteria, the NCCDM will provide some recommendation on the approval of the projects to the DNA. The screening results of projects are from the advice of the Technical Committee on CDM (TCCDM). Besides that, the NCCDM helps the DNA in developing CDM national policies, strategies, national CDM criteria and guidelines for implementation of CDM projects. As a requirement in

the CDM, the members of NCCDM should meet more than three times every year, or more often if necessary [49].

4.4. GreenTech Malaysia

There are three core technical committees in the institutional administration. GreenTech Malaysia, formerly known as Malaysia Energy Centre (PTM), possesses five main criteria for the CDM projects. Firstly, the project must lead to sustainable development to the society, in terms of social, economic and environmental. Secondly, unilateral projects are not allowed since involvement of an Annex I country must be met. Thirdly, Malaysia must obtain benefits through improved or transferred technology. Fourthly, criterion stated by the CDM Executive Board (EB) must be fulfilled, such as real, measurable and long-term benefits related to mitigation of climate change. Fifthly, the project must have the ability to be implemented, for instance, having secured financing [21,50].

4.5. CDM project cycle

In order to successfully claim the CERs in a CDM project, there are generally 10 steps to go through as shown in Fig. 7. Firstly, the project developer in private or public sector will come out with a new CDM project idea after some planning and establishment. And then, a Project Idea Note (PIN) will be prepared by the project developer to be submitted to the National Committee on CDM (NCCDM). The PIN is a brief description that provides indicative information of the project activity. Usually the PIN consists of type and size of the project, location, the anticipated total amount of GHGs reduction compared to the baseline scenario, suggested crediting life time, suggested CER price in $/tonne CO_2eq reduced, financial structuring and socio-economic or environmental benefits. It is noteworthy that a project is unnecessarily started with a PIN.

After receiving the Project Idea Note (PIN) from the project developer, the Technical Committee assisted by the Secretariat will evaluate the project based on the national criteria. If the project is acceptable, the NCCDM will approve the project and authorise the project partners to participate in a CDM project by issuing a conditional letter of approval. This document permits the development and adoption of Project Design Document (PDD) by the CDM Executive Board (EB). A PDD is a standardised document which provides a more detailed description of the project activity. The contents of PDD basically include the general description of project activity, baseline methodology, duration of the project activity, monitoring methodology and plan, calculations of GHGs emissions by sources, environmental impacts and stakeholders' comments [51]. For small scale projects, the PDD is not too demanding for documentation where the modalities and procedures for small-scale projects are largely simplified. To be qualified as small-scale projects, the CDM projects must not exceed some specified requirements as stated in paragraph 6 (c) of decision 17/CP. 7 [52,53]:

– Renewable energy (RE) projects must not be more than 15 MW in capacity;
– Energy efficiency (EE) improvement projects which reduce up to an equivalent of 60 GW hours on energy consumption per year either on the supply or the demand side;
– Other projects that both reduce emissions and emit less than 60 kilotonnes of CO_2 equivalent annually;
– Afforestation or reforestation measures or action that results in GHGs removals of less than 16 kilotonnes of CO_2 per year; and
– Developed or implemented by low income communities and individuals as determined by the host party.

Subsequently, the finalised PDD will be sent to the Designated Operational Entity (DOE) for validation. A DOE is an independent auditor accredited by the CDM Executive Board (EB) to validate whether a project proposal achieves the eligibility requirements or verify if the implemented project has achieved expected GHGs emission reduction, and recommend the amount of CERs that should be issued. Usually, either validation or verification should be done to the same project if it is in large scale. Nevertheless, the CDM EB may authorise the DOE to perform both functions.

After validation by the Designated Operational Entity (DOE), it reaches the stage of carbon contracting. This process involves both the project developer and the CERs buyers. They need to negotiate and compromise, to subsequently sign the Emission Reduction Purchase Agreement (ERPA). This agreement comprises

a) The terms and conditions of credit delivery and payment between the project developer and the buyer with a standard contractual relationship;
b) Designated for the legal aspects of credit ownership; and
c) The terms of payment and delivery and risk management inherent to the transaction.

Next, the Project Design Document (PDD) must be submitted to the Designated National Authority (DNA) with an addition of administration fee. The administration fee will be imposed as shown in Table 2. After that, the DNA will send a final letter of approval to the project developer. If necessary, the project developer will be questioned on some detailed information or clarification on the project by members of the National Committee of CDM (NCCDM). The letter of approval is only valid for six months' time.

Some of the project developers might choose to skip the process of submitting Project Idea Note (PIN). This is allowable with the replacement of Additional Information Sheet (AIS) submission. This form requires information on the efforts of the project to achieve

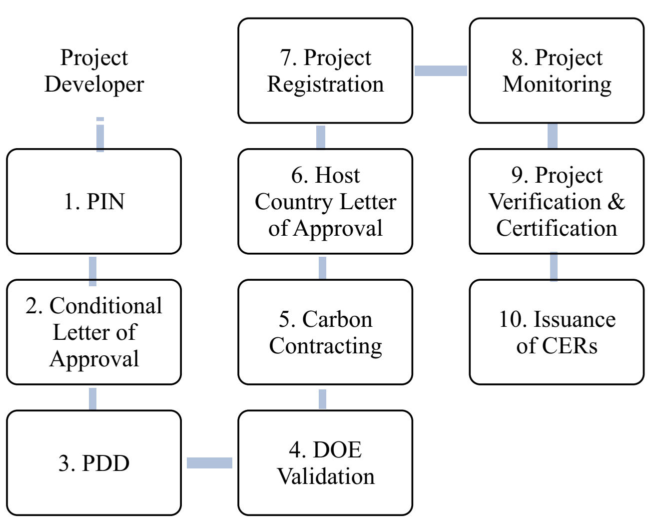


Fig. 7. National CDM project cycle.
Source: *Malaysia Energy Centre, 2008* [20].

Table 2
Marginal cost of reduction in investor and host country.
Source: *Malaysia Energy Centre, 2008* [20].

Type of document submitted	Administration fee (RM)
PIN	1,000
PDD	2,500 (small-scale project[a]) 5,000 (large-scale project[a])

[a] As defined by the CDM Executive Board (EB).

sustainable development and technology improvement. This information is vital to be the references for the decision makers—the NCCDM.

And then, the DOE will pass the validate PDD and the approval letter to the CDM Executive Board (EB) for official registration to declare the project as a CDM project. Although registration implies that the validated project has been formally accepted by the EB as a CDM project, the board can request to review the project before giving consent to its registration.

Certainly, the declaration as a CDM project does not means an end to the procedure of CDM qualifying. When the operation of project has been commenced, it will be monitored to identify the actual amount of emission reductions. Through measuring and recording the performance-related indicators, it can review whether the anticipated emission reductions prior to the project operation have actually been achieved. The monitoring activities will be conducted based on an approved monitoring methodology. Within the project boundary, the data collected during monitoring should give sufficient information on the emissions regarding the performance of the project activities.

Same as stage 4, the DOE will take up the responsibilities to verify the validation of the CDM project whether the CERs have resulted according to the guidelines and condition. The project developer has the right to decide the frequency of verification activities, within the acceptance of the DOE. The transaction cost will rise up if the frequency of verification increases, however, the CERs can be issued and transacted more frequently. The verified CDM project will be certified with written assurance by the DOE.

Finally, the completion of certification report will be followed by the issuance of CERs. This process will be instructed by the Executive Board (EB). Six to 12 months time required for a CDM project to be accepted and registered, subject to the completeness of the project including documents and verification process. As a follow up, the project developer will update the DNA on their project development once every six month. In addition, the Secretariat including GreenTech Malaysia, MARDI and FRIM will monitor the CDM project through site visits, depending on criticality of the project, that is, project implementation and CER issuance.

Since the ratification of Malaysia in the CDM in 2002, some of the projects' developers in the country started to apply for CDM projects. Number of projects applied in CDM increases from 3 projects in 2002 to 40 projects in 2007. It accounts 9.2 million tonnes of CO_2 equivalent in 2007 [54,55]. Until February 2008, there are 48 PIN and 61 PDD received by the Malaysia Energy Centre (PTM). The number of registered CDM projects in energy sectors including renewable energy and energy efficiency projects from 2006 to 2012 is presented in Table 3. Particularly, renewable energy and energy efficiency projects account 95 and 7 projects respectively throughout these 7 years. It brings more than 7 million tonnes of CO_2e emission reductions which largely contributed by 1,743,966 tCO_2e in 2009 and 1,790,108 tCO_2e in 2012.

Table 3
Number of registered CDM projects in energy sectors.

Year of registration	Number of energy projects		Emission reductions (tCO_2e)
	Renewable energy	Energy efficiency	
2006	12		1,682,653
2007	6	3	444,683
2008	7		314,714
2009	27	1	1,743,966
2010	5		273,492
2011	12	2	789,689
2012	26	1	1,790,108
Total	**95**	**7**	**7,039,305**

5. Discussion

"The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3."

The above statement is stated in the Article 12 (2), Kyoto Protocol. Significantly, the CDM has two main objectives which are designated to both developed and developing countries. Firstly, the CDM aims to assist developed countries to fulfil their commitments to reduce carbon emissions. Next, it helps the developing countries in achieving sustainable development. The CDM creates a platform for the countries to be connected and to cooperatively conserve the environment. Sustainable development is a steady and long-lasting development that meets the needs of present generation without compromising future generation [56]. Environment, social and economy are the three main pillars of sustainable development. When three of the above aspects can be developed in stable state, sustainable development will be achieved.

5.1. Benefits of CDM

For a developing country like Malaysia, CDM is not compulsory yet is a crucial identity to the projects as it gives positive return to the projects. A CDM project can be described as a sustainable and environmentally beneficial project. The most significant difference between a CDM project and a conventional project is that, the CDM project brings extra incomes. Both profitable conventional project and CDM project gain money in the end of their investment. However, positive environmental contribution of CDM project will be accounted in the carbon trading mechanism. After a certain period, the CDM projects can earn carbon credits from the Annex I countries besides gaining other development benefits. Contrarily, the conventional project can only earn profits depending on its own performance for investment and financial returns.

The first beneficiary in CDM projects are the developing or non-Annex I country. Through the sales of CERs from CDM projects, the developing countries have economic improvement directly or indirectly. By adopting the technology and assistance from the developed countries, more environmental friendly projects are validated by CDM in Malaysia. This in turn will bring higher profits to the host country. As a result, the national economy of the country will be improved. Subsequently, these stimulate the growth of more renewable energy, energy efficiency and other environmental friendly industries. These will create more opportunities for economy growth in the end.

In term of social aspect, the CDM also come up with many benefits. As mentioned in the above paragraph, labour conditions can be improved through CDM projects and it consequently will improve the living conditions of the nations. This is due to cleaner and greener environment ensures better life. Besides this, health, safety and welfare of local people can be secured. This is due to less exposure of the workers and the adjacent residents from hazardous particles especially in the project that reduces carbon emissions such as waste management and energy efficiency. As a consequence of healthier environment, the labours and residents may avoid high medical check-up or medication fees, furthermore, reduce the rate of mortality.

In addition to the economical and social benefits, CDM projects also give bonus to the environmental aspect. This is also the main aims

of CDM as the mechanism is also known as the cleaner environment driver. Besides reducing carbon emissions, the CDM projects bring a lot of advantages to the environment. For instance, by promoting comprehensive usage of the local natural resources such as biomass, solar energy and hydropower, the pressure from energy depletion can be alleviated and hence, diversify the energy sources in order to avoid intensive dependence on fossil fuels. Efficient utilisation of natural resources can also be achieved especially by the energy efficiency projects. For instance, recycling programmes generate by-products that are less harmful to mother Earth.

Moreover, the CDM projects can reduce the level of noise, odours, dust and pollutants to the environment. Due to improvements in technology utilisation, the gaseous emissions, effluent, odour and noise pollution can be well treated before released to the environment. These enhance indoor air quality and also reduce burdens to the environment.

Besides giving advantages to the developing countries, the CDM projects also bring benefits to the developed countries. Usually the developed countries are the main contributors to carbon emission. They meet their commitments by reducing carbon emissions to a specified level as agreed in the Kyoto Protocol through the CDM projects in developing countries. For instance, one of the Annex I countries Denmark emitted 70 million tonnes CO_2 equivalent in 1990. In order to reduce 300,000 t CO_2 equivalent from 2007–2012, Denmark had signed five Emission Reductions Purchase Agreements with Malaysia. These agreements are expected to achieve 1.1 million CERs, or around 7% of annual reduction obligation. As a consequence, the CDM projects are estimated to fulfil the Denmark's reduction obligations [21].

5.2. Challenges of CDM

The Kyoto Protocol expired in 2012 [57,58]. Second international agreement regarding carbon reduction is yet to be implemented [59]. The introduction of CDM in Malaysia brings uncounted benefits to the country. Many CDM projects have been ratified. Some of them gain more extra income through carbon trading compared to their daily operations. The main objectives of the CDM have been achieved in the country. Sustainable development has been obtained and technology has been transferred from advanced countries.

Nevertheless, the extent of improvement is ambiguous and controversial. Many small scale renewable energy projects claim that the CDM does not achieve the objective of technology transferring. Small scale projects are said as less exposed to technology transfer [60]. The international transfer of wind technology from 1988 to 2007 proofed that the extent of technology transfer between developed and developing countries is less obvious [61]. Since all of the CDM projects are expected to involve technology transfer, this disappoints some of the parties as the CDM contributes less technology transfer [61,62].

Some people claims that CDM has not been very successful in reducing carbon emissions [63]. Many actual CDM projects do not reflect actual reductions in emissions [64]. The nation-wide indirect and direct effects are required to be considered in CDM projects [22]. However, some researchers have different opinions against the above comments. According to Banuri and Gupta [65], the CDM projects introduce many less GHG-intensive technologies to the non-Annex I countries. Next, Kallbekken [66] found that

Table A1
CDM projects grouped in types [32].

Type	CDM							
	Number		CERs/year (000)		2012 CERs (000)		CERs issued (000)	
Wind	2,523	28%	232,036	19%	312,679	12%	71,729	7%
Hydro	2,280	26%	316,853	26%	416,765	16%	94,482	10%
Biomass energy	906	10%	61,000	5%	157,093	6%	24,717	3%
Methane avoidance	776	9%	34,270	3%	96,666	4%	11,298	1%
EE own generation	481	5%	63,560	5%	183,561	7%	44,105	5%
Landfill gas	434	5%	65,831	5%	190,088	7%	24,688	3%
Solar	333	3.8%	11,464	0.9%	6,366	0.2%	145	0.01%
EE industry	163	1.8%	7,568	1%	17,165	1%	2,052	0.2%
Fossil fuel switch	150	1.7%	69,509	6%	167,428	6%	33,614	3%
Coal bed/mine methane	112	1.3%	72,128	6%	103,791	4%	15,387	1.6%
EE supply side (power plants)	110	1.2%	59,168	5%	51,187	2%	1,656	0.2%
EE households	108	1.2%	4,107	0.3%	5,282	0.2%	135	0%
N_2O	107	1.2%	57,793	5%	251,769	10%	212,767	22%
Afforestation and reforestation	69	0.8%	3,285	0.3%	20,956	0.8%	4,072	0%
Fugitive	66	0.7%	49,353	4%	84,158	3%	9,834	1%
Cement	50	0.6%	7,578	1%	26,568	1%	2,154	0.2%
Transport	48	0.5%	5,823	0.5%	7,030	0.3%	439	0%
EE service	37	0.4%	1,720	0.14%	1,022	0.04%	6	0%
Geothermal	35	0.4%	12,210	1%	13,242	1%	4,206	0.4%
Energy distribution	29	0.3%	10,422	1%	9,910	0%	316	0%
HFCs	23	0.3%	81,727	7%	476,504	18%	414,363	43%
PFCs and SF6	18	0.2%	5,540	0%	11,785	0.5%	1,758	0.2%
Mixed renewable	6	0.07%	412	0%	140	0.01%		
CO_2 usage	4	0.0%	116	0%	287	0.01%	10	0.001%
Agriculture	2	0.02%	59	0%	41	0%		
Tidal	1	0.01%	315	0%	1,104	0.04%		
Total	**8,871**	**100%**	**1,233,845**	**100%**	**2,612,586**	**100%**	**973,934**	**100%**
HFCs, PFCs, SF and N_2O reduction	148	1.7%	145,060	12%	740,058	28%	628,889	65%
Renewables	6,084	69%	634,290	51%	907,389	35%	195,279	20%
CH_4 reduction and Cement and Coal mine/bed	1,444	16%	229,336	19%	501,598	19%	63,371	6.5%
Supply-side EE	620	7%	133,149	11%	244,658	9%	46,078	4.7%
Fuel switch	150	1.7%	69,509	5.6%	167,428	6.4%	33,614	3.5%
Deman-side EE	308	3.5%	13,394	1.1%	23,469	0.9%	2,193	0.2%
Afforestation and Reforestation	69	0.8%	3,285	0.3%	20,956	0.8%	4,072	0%
Transport	48	0.5%	5,823	0.5%	7,030	0.3%	439	0.05%

CDM can significantly reduce carbon leakage with reduced emissions trading permit prices, which lower the abatement cost in Annex I countries. A study by Huang and Barker [67] also shows that, reduction in CO_2 emissions is foreseen in the CDM host countries in the long run.

So, a new international agreement should be enacted in future to continue the mission of reducing carbon emission and assuring sustainable development. The agreement might bind the developed and developing countries in a different way with Kyoto Protocol. Nevertheless, global cooperation in improving the environment condition is necessary by applying carbon trading concept into the next international agreement.

Since renewable energy sector is the most in the CDM projects, the developer is encouraged to utilise more of the mature renewable energy technologies such as biomass, mini-hydro, solar power, wind power and so on. Certainly, exploration of new renewable energy is necessary to diversify the renewable energy sources and provide sufficient choices of energy sources to the end users. Besides, the attractive carbon credit from CDM is also a reason for developing more renewable energies.

6. Conclusion

Most of the CDM projects are renewable energy projects. It recorded 69% out of total CDM projects. This means that, renewable energy projects are more viable in getting CDM recognition. Malaysia should diversify the exploitation of renewable energy. For example, solar energy, biomass and tidal energy are potential renewable energy since the country possesses abundant natural resources. In the point of views of most of the developing countries, CDM is encouraged to be continued as it brings a lot of advantages to them. CDM does help in encouraging more RE projects, especially for biomass and biogas. Therefore, it is anticipated to encourage more new renewable technology in Malaysia including wind energy and tidal energy.

However, utilisation of renewable energy faces several barriers for more new projects. It is due to high cost of renewable energy, lack of project funding and low demand for energy from renewable resources. The number of CDM projects is still low if compared to countries like China, Mexico, India and Korea. Hence, the project developers are encouraged to participate in the CDM actively. The renewable energy sector in the country is potential to get the most CDM projects. So, investment on more renewable energy projects is highly encouraged. This will gives many benefits and conveniences to the renewable energy projects development.

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Appendix A

See Table A1.

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